近親婚の死亡率におよぼす影響 (多変量統計解析)

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この論文は 1974年8月 ルーマニアで開催された The 8th. International Biometric Conference の Statistical Methods in Human Genetics 部会に於る Certain Statistical Methods in the Analysis of the Effect of Inbreeding on Mortality と題する招待講演の紹介である。内容が長いので、目次と、付表等を付けるに止める。

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Table 1

The Basic Data

group	inbreeding coefficient	total pregnancies	natural abortions	still births	deaths up to 12 months	deaths 13-60 months	Surviving children
A Rural district	0	958	27	15	57	25	834
	1/64	160	1	1	13	6	139
	1/32	60	3	2	7	2	51
	1/16	293	12	2	18	11	250
B Intermediate district	0	2670	67	20	128	76	2379
	1/64	338	11	1	25	10	291
	1/32	237	11	4	14	12	196
	1/16	654	23	6	40	27	558
C Urban district	0	543	7	5	21	14	496
	1/64	70	4	0	1	2	63
	1/32	110	3	0	5	2	100
	1/16	260	7	1	15	11	226

Reproduced from table 1 of Tanaka [8]

Table 2

Expanded X-matrix

column number	1*	2*	3*	4*	5*	6*	7*	8*	9*	10*	11*	12*	13*	14*	15*	16*	17*	18*	19*	20*
Expanded X matrix	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	0	0	0	0
	1	0	0	1	2	0	0	2	4	0	0	4	1	0	0	1	0	0	0	0
	1	0	0	1	4	0	0	4	16	0	0	16	1	0	0	1	0	0	0	0
	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	0	0	0
	0	1	0	1	0	2	0	2	0	4	0	4	0	1	0	1	0	0	0	0
	0	1	0	1	0	4	0	4	0	16	0	16	0	1	0	1	0	0	0	0
	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	0	0
	0	0	1	1	0	0	2	2	0	0	4	4	0	0	1	1	0	0	0	0
	0	0	1	1	0	0	4	4	0	0	16	16	0	0	1	1	0	0	0	0

The 12×20 matrix in this table is the expanded X matrix used in the present analysis. The number with * represents the name of a column.

Table 3

Analysis and the columns, in the expanded X matrix, used in the analysis.

analysis,	columns used
A1:	1* 5* 9*
A2:	1* 5*
A3:	1*
B1:	2* 6* 10*
B2:	2* 6*
B3:	2*
C1:	3* 7* 11*
C2:	3* 7*
C3:	3*

analysis,	columns used
1: (2 2 2):	1* 2* 3* 5* 6* 7* 9* 10* 11*
2: (2 2 1):	1* 2* 3* 5* 6* 7* 12*
3: (2 1 1):	1* 2* 3* 8* 12*
4: (1 1 1):	4* 8* 12*
5: (2 2 0):	1* 2* 3* 5* 6* 7*
6: (2 1 0):	1* 2* 3* 8*
7: (1 1 0):	4* 8*
8: (2 0 0):	1* 2* 3*
9: (1 0 0):	4*

analysis,	columns used
A1':	13* 5* 9*
A2':	13* 5*
A3':	13*
B1':	14* 6* 10*
B2':	14* 6*
B3':	14*
C1':	15* 7* 11*
C2':	15* 7*
C3':	15*

analysis	columns used
1': (2 2 2)':	13* 14* 15* 5* 6* 7* 9* 10* 11*
2': (2 2 1)':	13* 14* 15* 5* 6* 7* 12*
3': (2 1 1)':	13* 14* 15* 8* 12*
4': (1 1 1)':	16* 8* 12*
5': (2 2 0)':	13* 14* 15* 6* 6* 7*
6': (2 1 0)':	13* 14* 15* 8*
7': (1 1 0)':	16* 8*
8': (2 0 0)':	13* 14* 15*
9': (1 0 0)':	16*
10': (2 0 0)"	17* 18* 19*
11': (1 0 0)":	20*

The numbers with asterisks represent the columns in the 36. different analyses. In the triplet numbers (i,j,k) k=0 shows quadratic term is not included, k=1 included and homogeneous for three groups, and k=2 included and heterogeneous, respectively. j and i do the dame for linear and constant terms. The prime notation, (·)', indicates that the analysis involves those of related related marriage groups whereas the double prime notation, (·)", indicates only those of unrelated marriages.

Fig. 2.1

The significance levels of the tri-variate analogue of the one-sided test where the alternative is the direction as indicated. The triplet figures indicates the regression model by which the estimate of the mortality at f=0 is obtained.

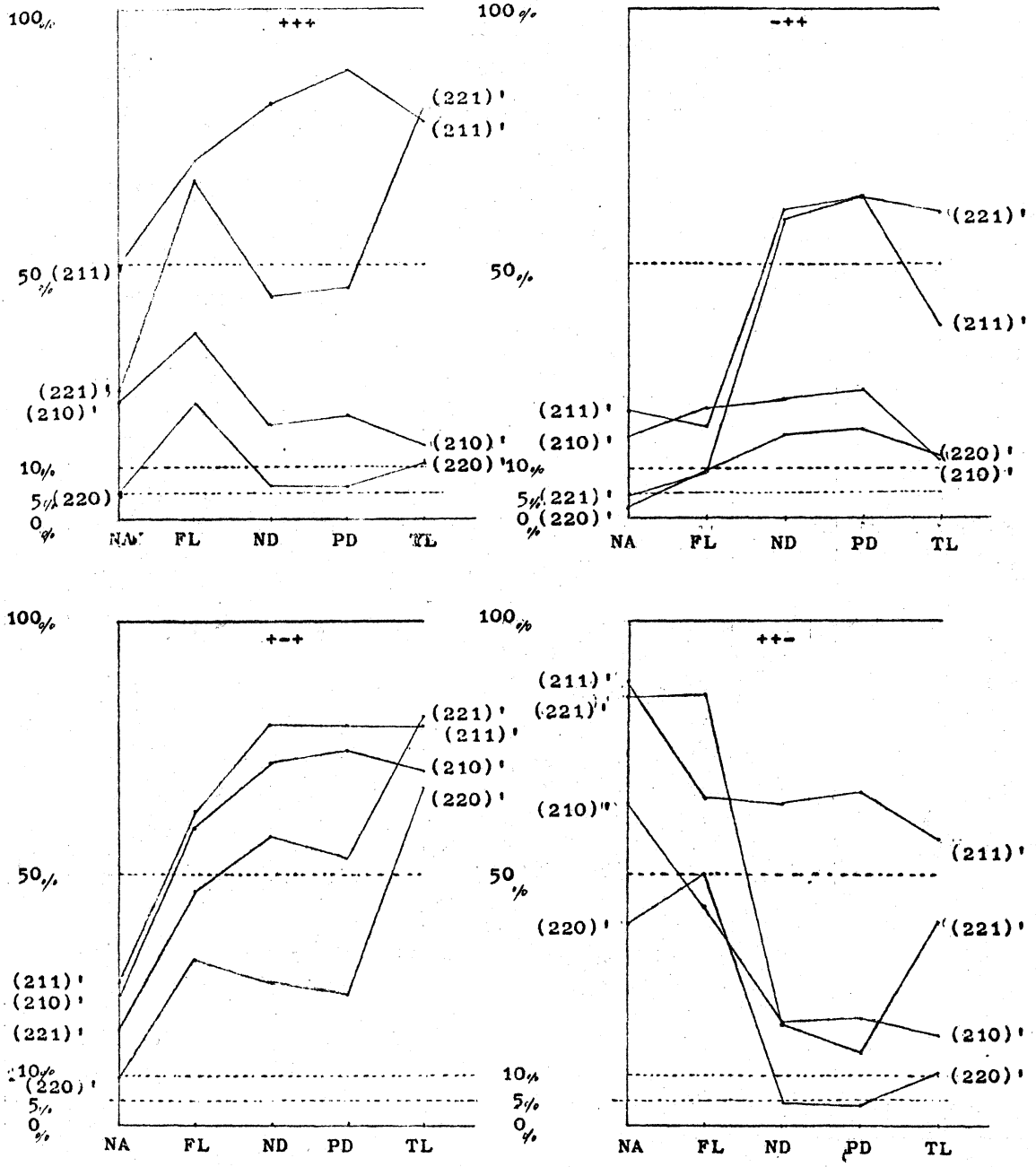

Table 5

significance levels of linear and quadratic terms in the binomial models.

Analysis	Binomial Model	significance level of Linear Term	significance level of Quadratic Term
(2 2 2)	N. A.	⊖.239 .045 .043 .032(.095)	⊕ ⊖ ⊖
	F.L.	⊖.291 .022 .180 .103(.268)	⊕ ⊖ ⊖
	N.D.	.045 .043 ⊖.477 .042(.122)	⊖ ⊖ ⊕
	P.D.	.039 .014 ⊖.285 .015(.047)	⊖ ⊖ ⊕
	T.L.	.114 .003 ⊖.495 .008(.027)	⊖ ⊖ ⊖
(2 2 1)	N.A.	.055 .051 .048 .263(.390)	⊖.107
	F.L.	.119 .064 .106 .330(.476)	⊖.138
	N.D.	.045 .031 .018 .112(.180)	⊖.046
	P.D.	.027 .010 .010 .064(.105)	⊖.043
	T.L.	.012 .003 .004 .022(.038)	⊖.022
(2 1 1)	N.A.	.046	⊖.110
	F.L.	.072	⊖.135
	N.D.	.021	⊖.046
	P.D.	.011	⊖.043
	T.L.	.004	⊖.021
(2 2 0)	N.A.	.113 .046 .111 .041(.120)	
	F.L.	.324 .034 .267 .103(.268)	
	N.D.	.361 .059 .093 .085(.228)	
	P.D.	.184 .006 .035 .004(.015)	
	T.L.	.158 .000 .003 .001(.003)	
(2 1 0)	N.A.	.009	
	F.L.	.031	
	N.D.	.030	
	P.D.	.000	
	T.L.	.000	

The figures represents the significance levels of one-sided normal tests, and below triplet of figures the levels of the one sided analogue of the tri-variate normal test and of all sided test (inside bracket). ⊖ indicates the tendency against the anticipated inbreeding depression.

Abbreviations : N.A. : natural abortions, F.L. : fetal losses, N.D. : neo-natal deaths, P.D. : post-natal deaths, T.L. : total losses.

Fig. 1

The single and double circle indicate that the test of goodness of fit is significant at 5% and 1% levels respectively. An arrow inclicates that new parameters are included and thus the comparision of χ^2 value is lesitimate, and a shaded arrow indicates that the decrease is significant at 5% level.

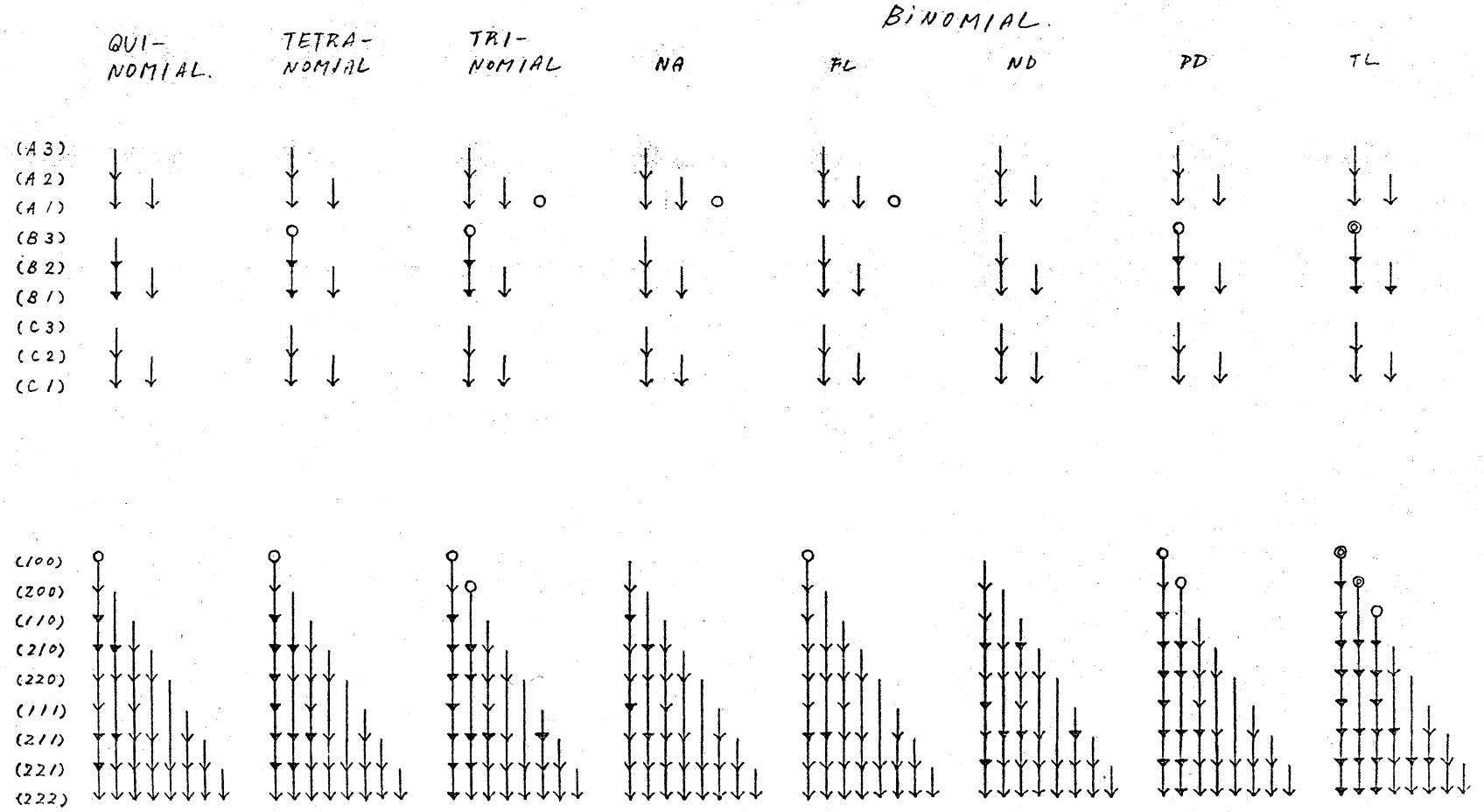

Table 4

The model and the significance level of ordinary χ^2 test of goodness of fit

Model	quinomial	tetranomial	Trinomial	binomial				
Name of binomial model				Total loss	Natural Abortion	Fetal Loss	Neo-Natal Death	Postnatal Death
Natural Abortion	o	o	o	o	o	o	×	×
Still Birth	o						×	×
Deaths up to 12 months	o	o	o		o	o	o	o
Deaths within 30-60 months	o	o						
Survived	o	o	o	o			o	
A3	.3539	.3252	.2095	.2477	.1639	.1299	.3462	.3130
A2	.2664	.1833	.1148	.2198	.1694	.0675	.2090	.2566
A1	.1532	.0912	.0446	.1922	.4767	.0132	.6170	.8065
B3	.0527	.0240	.0119	.0021	.1667	.0679	.1293	.0254
B2	.2361	.1869	.1647	.0832	.3430	.1686	.1939	.2253
B1	.3274	.3661	.5272	.6891	.6629	.2693	.2964	.8230
C3	.2856	.4934	.2778	.2680	.0813	.3916	.3885	.2105
C2	.3490	.5907	.4437	.8693	.0533	.2566	.5352	.5945
C1	.4295	.3900	.3790	.7082	.1116	.1936	.2986	.6241
(1 0 0)	.0483	.0433	.0113	.0015	.0921	.0481	.0836	.0315
(2 0 0)	.0828	.0799	.0204	.0068	.0504	.0718	.2138	.0428
(1 1 0)	.2377	.2325	.1033	.0469	.2463	.0824	.1320	.2499
(2 1 0)	.4578	.4962	.2723	.3248	.1754	.1459	.4056	.4858
(2 2 0)	.2079	.2215	.1264	.2182	.0727	.0697	.2632	.3445
(1 1 1)	.3235	.3647	.1826	.1233	.3213	.1037	.2583	.4354
(2 1 1)	.6180	.7171	.4822	.7062	.2733	.2117	.6745	.7587
(2 2 1)	.3361	.4009	.2635	.5993	.1225	.1006	.5252	.6400
(2 2 2)	.2338	.1795	.1503	.5723	.0842	.0292	.4899	.9503

The four causes of deaths are separately treated in the quinomial model. The first two, the pre-natal deaths, are combined to form the tetranomial model. Prenatal and postnatal deaths are combined in the trinomial model. All the four are combined in the total loss binomial model. The natural abortion and Fetal loss binomial models are self explanatory, and in the remaining two binomial models pre-natal deaths are deleted.

Fig. 2.2

For explanation, see Fig. 2.1